Biology of the Fiery Skipper, *Hylephila phyleus* (Lepidoptera: Hesperiidae), a Turfgrass Pest in Hawaii[1]

H. TASHIRO[2] and W.C. MITCHELL[3]

ABSTRACT

Field collected females of the fiery skipper, *Hylephila phyleus* (Drury), oviposited almost immediately when placed in a screen cage 24 × 24 × 24 cm and held in the greenhouse under natural daylight at diurnal temperatures of 26.5 to 35.0°C. Oviposition medium was closely cut FB–137 bermudagrass, *Cynodon* spp. More than 60% of the eggs, deposited singly, were placed on the lower surface of blades. There were no sexual differences in larval size or developmental rate. Laboratory reared females began ovipositing on the third day following eclosion peaking during the fifth through the ninth day. Laboratory reared females produced more viable eggs when held in a 61 × 99 × 66 cm cage than in a 24 × 24 × 24 cm cage, indicating a possible need for greater flight activities for normal reproductive development.

The fiery skipper, *Hylephila phyleus* (Drury) was first discovered in Hawaii in Honolulu on the island of Oahu in early September 1970 (Kawamura and Funasaki 1971). By 1973 its presence was noted in numerous areas of Oahu, including the windward as well as the leeward side of the island. Since then it has been found on all the Hawaiian Islands except Lanai (P. Lai, Hawaii State Department of Agriculture, personal communication; Miyahira and Nakahara 1981; Bianchi 1983).

Okumura (1959) indicated that it is found in residential and agricultural areas throughout California while Klots (1951) stated that it occurs from South America north to Connecticut, Michigan and Nebraska and is abundant in much of the south, presumably referring to the United States.

Adults are the most frequently seen form as the rapid flying butterflies frequent flowers of lantana, honeysuckle, alfalfa, clover and other flowers to feed on nectar. They have a wing span of 2.5 to 3.2 cm. Males are predominantly bright orange-yellow above and pale yellow with sub-marginal dark spots on the underside of both fore and hind wings. Females are predominantly dark brown on the upper surface and of similar coloration as the male on the underside but much overlaid with olivaceous dusting (Klots 1951). The larvae feed on all the common lawn grasses with possible preference for bermudagrasses *Cynodon* spp. and bentgrasses *Agrostis* spp. (Okumura 1959). Early symptoms of infestation are characterized by isolated round spots with lack of leaf blades (Bohart 1947).

Larvae are seldom seen, even when abundant, since they remain concealed in lightly woven silken tubes in the thatch area. During two different 6-month periods (1975 and 1982) I did not see a single larva on the turfgrass although a few were observed under plywood placed on turf overnight as a sampling technique (Mitchell and Murdoch 1974) and a few were forced to the turfgrass surface with liquid irritants (Tashiro, Murdoch and Mitchell, in press). From these facts, the fiery skipper is considered to be a nocturnal feeder.

[1]Journal Series No. 2766 of the Hawaii Institute of Tropical Agriculture and Human Resources.
[2]Visiting Entomologist, Department of Entomology, University of Hawaii, on sabbatical leave from Cornell University, New York State Agricultural Experiment Station, Geneva, NY 14456.
[3]Entomologist and Professor, Department of Entomology, University of Hawaii, 3050 Maile Way, Honolulu, HI 96822.

In Hawaii it is presently considered to be either the third or fourth most serious lepidopterous turfgrass pest, but it has the potential of being a most serious pest during the warmest period of the year. Because of this potential, I studied its biology during the first half of 1982.

METHODS AND MATERIALS

Field observations showed that the butterflies are very rapid fliers with darting movement especially when a male is pursuing a female. Although flights are slightly slower when seeking blossoms, they are still difficult to net. Females alight on the turf for a few seconds for oviposition before flying a short distance to repeat the process. Males also were found to alight a few seconds in like manner. Through the efforts of Mr. John Morgan, who collected butterflies on the greens of the Honolulu Lawn Bowling Association, I was able to start a laboratory culture which made the study possible. Most of the adults were netted one at a times as they alighted on the turf.

The butterflies were divided roughly equally into four groups containing males and females. Three groups were placed in 24 × 24 × 24 cm screen cages and held in 3 different environments. The first was an incubation chamber maintained at 27.5–29°C roughly 50–80% RH with a light:dark cycle of 12:12 hr with illumination furnished with an incandescent lamp. The second was at a window in the laboratory maintained at roughly 23–27°C with RH getting as low as 40% and outdoor light:dark cycle. The third was in a greenhouse where daylight temperatures fluctuated from about 26.5 to 35.0°C and RH of 50–80%. The fourth group was placed in a much larger screen cage occupying approximately .3 m^3 held outdoors but always in the shade.

Adult skippers were first furnished a 10% honey solution dispensed from wet cotton from which they fed. Near the end of the studies potted blooming lantana *(Lantana camara* L.*)* was placed in the cages and adults readily fed on nectar (Fig. 1). A tray of healthy FB 137 bermudagrass trimmed at 2–3 cm height was furnished as an oviposition medium.

When the highly visible eggs were present, the grass blades and stems were clipped from the tray and placed in 9 cm diam. petri dishes containing a moistened filter paper. The dishes were covered and held in the incubator chamber described above. Newly hatched larvae were maintained in the same dishes with addition of freshly cut bermudagrass blades. As the larvae grew, the numbers per dish were gradually reduced until there were no more than 2–3 per dish. Dishes were frequently renewed as the debris accumulated.

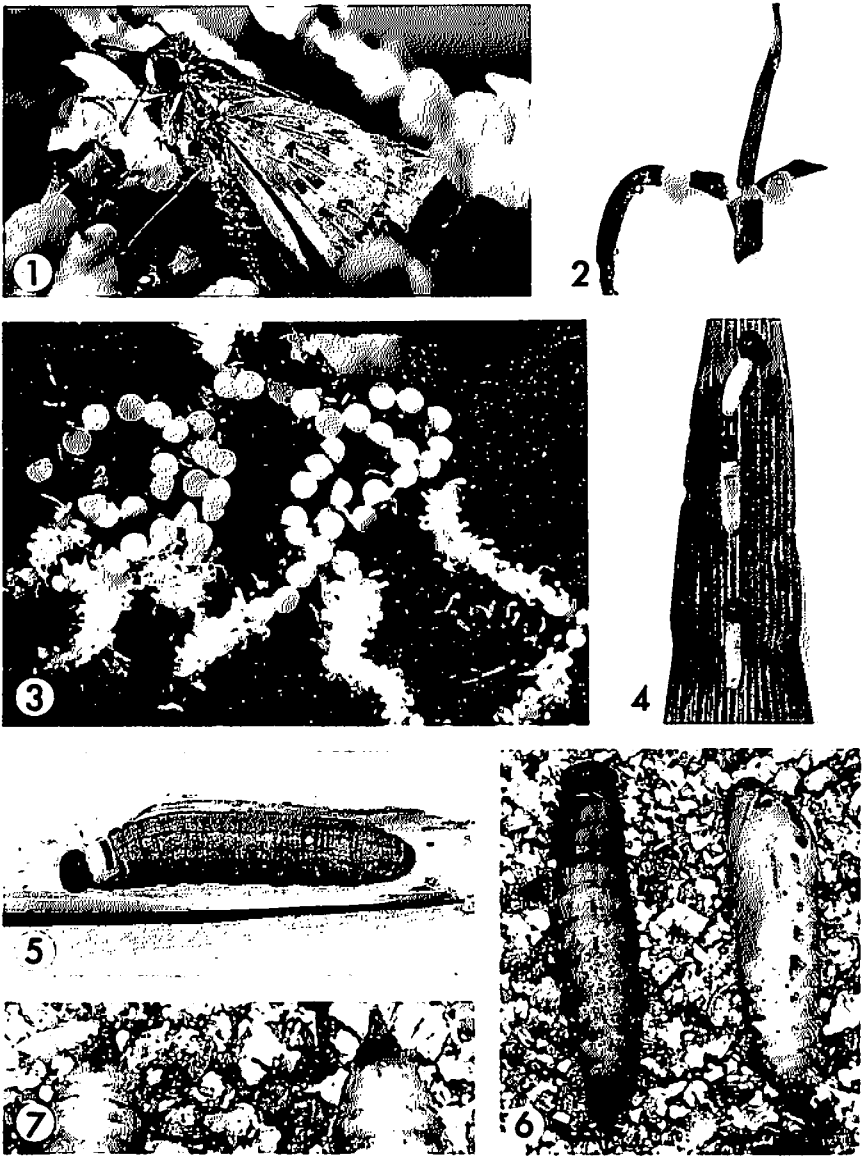
For individual rearing, newly hatched larvae were transferred individually with a fine artists brush to plastic vials of 2.5 cm diam. × 5.0 cm in length and furnished fresh grass blades as needed. Snap cap lids with several minute holes pierced with a fine needle prevented rapid drying of the grass.

Both petri dishes and vials were washed with detergent and hot water, rinsed in hot water and drain-dried. No disinfecting agent was used and there was no evidence of any detrimental microorganism affecting the larvae.

RESULTS AND DISCUSSIONS

Oviposition by Field Collected Adults

Of the four environments under which the original field collected adults were held, eggs were deposited only in the cage held in the greenhouse under natural light and relatively high daylight temperatures of 26.5–35°C. When held under these



FIGURES 1-7. Stages in the life history of the fiery skipper: 1. Female feeding on lantana nectar; 2. Eggs on underside of bermudagrass blades; 3. 4-branched ovaries; 4. Ist-instars on bermudagrass blade; 5. Full grown 5th (ultimate) instar; 6. Prepupa and pupa; 7. Pupal terminalia male (left) and female (right).

TABLE 1. Oviposition site of fiery skipper moths in 24 × 24 × 24 cm screen cages held in greenhouse with FB 137 bermudagrass as oviposition medium.

Date(s) of oviposition	No. eggs on various parts of plant				Total eggs
	Leaf surface				
	Lower	Upper	Stem	Others[a]	
May 10	17	0	2	1	20
11	33	21	3	7	64
12–13	31	13	19	9	72
14–15	50	5	4	4	63
16–17	47	1	14	3	65
June 21[b]	23	3	2	0	28
Total	201	43	44	24	312
% of total	64.4	13.8	14.1	7.7	

[a]Surface plant debris and soil surface.
[b]Adults reared and mated in captivity; all others field collected females.

TABLE 2. Head capsule widths and total lengths (in mm) of fiery skipper larvae reared from egg to adult.

	Larval Stadia				
	1	2	3	4	5
	Head capsule width — males				
Mean	.44	.69	1.21	1.75	2.80
Maximum	.50	.77	1.70	1.90	3.00
Minimum	.40	.60	1.00	1.50	2.70
SD	.00	.05	.21	.10	.01
n	17	15	13	15	9
	Head capsule width — females				
Mean	.44	.69	1.14	1.75	2.87
Maximum	.50	.77	1.25	1.93	3.00
Minimum	.40	.60	1.00	1.65	2.80
SD	.00	.05	.07	.05	.09
n	10	9	10	11	6
	Total length — males				
Mean	2.5	7.0	9.6	14.2	24.1
Maximum	3.9	11.5	11.6	18.6	29.0
Minimum	2.1	4.0	7.9	10.7	10.6
SD	0.5	2.9	1.1	2.0	2.6
n	12	15	13	12	11
	Total length — females				
Mean	2.4	6.7	10.2	16.0	23.7
Maximum	3.0	9.5	15.1	22.7	29.9
Minimum	2.0	5.5	7.6	12.4	17.9
SD	0.4	1.4	3.2	3.0	3.8
n	5	10	7	9	7

conditions oviposition began on the first day from about 10 a.m. and continued throughout the entire afternoon.

The site of oviposition on trays of bermudagrass was recorded for 312 eggs as shown in Table 1. Since eggs are deposited singly and lightly glued to the oviposition medium, the grass stems and blades could be carfully cut from the trays for closer examination. The lower surface of leaf blades was the most preferred, receiving 64% of all eggs. The stems and upper leaf surfaces were nearly equally preferred receiving about 14% at each site. Only about 8% were found elsewhere on plant debris and soil surface. It appeared that laboratory reared females had the same site preference as field collected females. Eggs obtained in this study were used for individual rearing to determine larval instars, size, and any possible sexual differences.

Description of Stages

Eggs: The pearly white hemispherical eggs are easily detected (Fig. 2). They turn powder blue after a day or two. Measuring 10 eggs at random yielded individual diameters of .70 to .75 mm and heights of .50 to .55 mm with means of .745 and .515 mm, respectively. These measurements compare favorably with those of Bohart (1947). Dissection of field collected females revealed a right and left ovary each with 4 branches (Fig. 3). The hemispherical eggs were powder blue.

Larvae: In the first group of 20 larvae reared individually, 10 were fed sections of sweet corn leaves and 10 were fed FB 137 bermudagrass leaves. Larval development was the same with both foods but as more food was required by growing larva, sweet corn leaves produced excessive free moisture detrimental to larvae. The bermudagrass leaves having less moisture did not create this problem. The second group of 20 reared individually were fed FB 137 bermudagrass throughout their entire immature life.

As larvae molted all head capsules were held in 70% alcohol for future measurements. Larval lengths were measured with a caliper under magnification only when the larvae were in a normal outstretched position. From an original 40 first instars, 33 were reared to adults and measurements on these individuals are summarized in Table 2. There were no real sexual differences in either head capsule widths or total lengths. They grew from first instars with head capsule widths of .40 to .50 mm with a mean of .44 to fifth instars with head capsule widths of 2.70 to 3.00 mm with means of 2.80 and 2.87 mm, respectively, for males and females. Larval lengths increased form first instars of 2.0 to 3.9 mm with means of 2.5 and 2.4 mm to fifth instars from 17.9 to 29.9 mm with means of 24.1 and 23.7. This compares favorably with results of Bohart (1947) who stated that larval length was about 25 mm.

The most unique characteristic of the fiery skipper larva is its strongly constricted neck (Figs. 4 and 5) apparent in all instars. The body gradually changes from a uniform green in the early instars to a brownish yellow distinctly granular surface. All larval instars have a black head and a back pronotal shield as a narrow transverse black band. Starting at the third instar, larvae actively spin profuse and strong webbing.

At a rearing temperature of 27.5–29°C it required a mean of 23.4 and 23.5 days from egg hatch to adults with no sexual differences in duration as shown in Table 3.

Prepupal period lasted less than a day with a mean of .5 day. In appearance they differed little from mature larvae except that they became rigidly straight (Fig. 6).

TABLE 3. Fiery skipper developmental rates (in days) at 27.5–29°C incubation for individuals reared from egg to adult[a].

	Larval stadia					Pre-		Total days hatching
	1	2	3	4	5	pupa	Pupa	to adult
				Males				
Mean	2.9	2.4	3.1	2.3	4.3	.5	7.9	23.4
Maximum	5	3	7	4	5	1	9	34.0
Minimum	2	2	2	1	2	<1	7	16.0
SD	1.0	0.5	1.4	0.7	0.8	0.5	0.6	2.1
				Females				
Mean	3.0	2.8	2.2	2.8	4.6	.5	7.6	23.5
Maximum	4	4	4	4	6	1	10	33.0
Minimum	2	2	2	1	4	<1	7	18.0
SD	2.2	0.6	0.6	0.7	0.7	0.5	0.0	1.4

[a]n = males, 17, females 11.

TABLE 4. Oviposition pattern of field collected and laboratory-reared fiery skipper females[a].

	No. eggs deposited each day									Total
Female	1	2	3	4	5	6	7	8–9	10–11	eggs
				Field collected females[b]						
1	14	0*								14
2	2	36	0*	–	–	–	–	–	–	38
3	6	3	17	–	18	1	19	34*	–	98
4	26	37	19	25	11	0*	–	–	–	118
5	19	87	35	26	1*	–	–	–	–	168
	67	163	71	51	30	1	19	34		436
				Lab reared females[c]						
1	0	0	0	0	0	0!	3	6*	–	9
2	0	0	0!	0	6	0	2	2	11*	21
3	0	0	0	18	4!	0*	–	–	–	22
4	0	0	17	5	0*!	–	–	–	–	22
5	0	0	0	0	0	32!	0	0*	–	32
6	0	0	0	0	25!	11	6	0	1*	43
7	0	0	0	0	0	7!	14	50*	–	71
			17	23	35	50	25	58	12	220

[a]Adults held in greenhouse at 27–35°C ambient in 24 cm³ screen cages containing honey solution as food and FB 137 bermudagrass tray as oviposition media.

[b]Field Collected adults assumed mated and caged individually.

[c]Lab reared adults caged as pairs within 24 hrs of eclosion. ! indicates death of male; * death of female.

TABLE 5. Viability of fiery skipper eggs from field collected and laboratory-reared adults in different size screen cages[a].

Total eggs[b]	No. hatching, days from oviposition					Total hatch	% hatch
	2	3	4	5	6		
			Field collected — 24 × 24 × 24 cm cage				
23	0	23	0	0	0	23	100
77	0	74	0	0	0	74	96
168	0	2	146	16	3	167	99
318	0	172	35	98	12	317	99
Daily totals	0	271	181	114	15	581	
Mean % hatch	0	47	31	20	3		99
			Lab reared — 24 × 24 × 24 cm cage				
54	0	0	5	4	0	9	17
67	0	1	0	0	0	1	1
91	0	1	2	1	0	4	4
Daily totals	0	2	7	5		14	
Mean % hatch	0	14	50	36			7
			Lab reared — 61 × 99 × 66 cm cage				
14	0	13	0	0	0	13	93
22	0	12	9	0	0	21	95
38	1	1	25	0	1	28	74
75	0	24	37	0	0	61	81
Daily totals	1	50	71	0	1	123	
Mean % hatch	1	41	58	0	1		86

[a]All cages held in greenhouse in full sun with flowering lantana for nectar as adult food and FB 137 bermudagrass as oviposition medium.

[b]Egg bearing grass blades removed daily and held in petri dish with moist filter paper at 27.5–29°C; larvae removed daily as hatched.

Pupae: The pupal period was the longest with means of 7.9 and 7.6 days, respectively, for males and females. Pupation occurred in loosely woven hibernaculum or no hibernaculum if material was absent. Color changed from a yellow-green young pupa to a light to medium brown mature pupa with color of forewings apparent a few hours before eclosion (Fig. 6). Separation of sexes in the pupal stage was possible by the methods of Butt and Cantu (1962) (Fig. 7).

Comparison of Field Collected and Laboratory Reared Adults

Field collected females were all assumed to be mated but were paired with males when available. My assumptions were undoubtedly true since all the females deposited eggs during the first day of captivity when held caged in the greenhouse (Table 4). Female longevity was rather short with longest period being 9 days from capture. They deposited irregular numbers of eggs as long as alive.

Laboratory reared females were paired with males within 8 hrs of emergence and held in a cage in the greenhouse. If we assume mating during the first day, the shortest pre-oviposition period was 3 days and the longest 7 days. The longest female life was 11 days for 2 females each depositing eggs to the last day. Male longevity was significantly shorter with 6 days being the longest (Table 4). Egg

deposition by laboratory reared females was much less than field collected females with the highest being 71 (Table 4).

Cage size was considered a possible detriment to oviposition and egg viability in laboratory reared females. Reared butterflies were held in the greenhouse in 24 × 24 × 24 cm cages as well as a larger cage of 61 × 99 × 66 cm and allowed to oviposit. Egg hatch of these two groups was compared with hatch of eggs from field collected females. Egg viability was very low with a mean of only 7% for eggs deposited by laboratory reared females in the smaller cage (Table 5). Egg viability was much improved when females were held in the larger cage. With a mean of 86% hatch, viability approached that of eggs deposited by field collected females with a mean of 99% hatch. These results indicate that flight activity may be critical to egg production and viability. Incubation period was similar in all 3 groups with most eggs hatching during the 3rd through the 5th day following oviposition.

Mass Rearing

Median stadia to mature larvae were placed in a plastic tray of ca. 20 cm diam. and ca. 8 cm deep in congested numbers and supplied bermudagrass stems and leaves as needed. Food debris and fecal matter were removed as needed to prevent excessive moisture. there was no evidence of cannabilism even under conditions considered as over-crowding. From ca. 100 larvae introduced ca. 70 pupated and ca. 40 emerged as normal adults. Under a little more care, it was apparent that mass rearing of the fiery skipper would be a practical approach to obtaining large numbers of reared adults.

ACKNOWLEDGMENTS

The initial collection of adults by Mr. John F. Morgan, President of the Garden Builders, Inc., contributed to the success in obtaining a laboratory culture. We are also grateful for his effort in obtaining permission for us to make additional collections on the turf of the Honolulu Bowling Greens Association. We also received assistance in collecting additional adults from Dr. Charles Murdoch and Mr. James Tavares of the Department of Horticulture, for which we are grateful.

REFERENCES CITED

Bianchi, F.A. 1983. Note on *Hylephila phylens.* Proc. Hawaii. Entomol. Soc. 24:191.

Bohart, R.M. 1947. Sod webworms and other lawn pests in California. Hilgardia 17:267–308.

Butt, B.A. and E. Cantu. 1962. Sex determination of lepidopterous pupae. US Dept. Agric. ARS–33–75.

Kawamura, K. and G. Funasaki. 1971. Note on *Hylephila phylens.* Proc. Hawaii. Entomol. Soc. XXI:21–22.

Klots, A.B. 1951. A Field Guide to the Butterflies of North America, East of the Great Plains. The Riverside Press, Cambridge, MA. 349 pp.

Mitchell, W.C. and C.L. Murdoch. 1974. Insecticides and their application frequency for control of turfgrass insects in Hawaii. Down to Earth 30:17–23.

Miyahira, N. and N. Nakahara. 1981. Note on *Hylephila phylens.* Proc. Hawaii. Entomol. Soc. XXIII:318.

Okumura, G.T. 1959. Illustrated key to the lepidopterous larvae attacking lawns in California. California Dept. Agric. Bull. XLVIII:15–21.

Tashiro, H., C.L. Murdoch and W.C. Mitchell. Development of a survey technique for larvae of the grass webworm and other lepidopterous species in turfgrass. Environ. Entomol. 12:1428–1432.